(19) Europäisches Patentamt / European Patent Office / Office européen des brevets

(11) **EP 4 144 492 B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
05.03.2025 Bulletin 2025/10

(21) Application number: **21850583.2**

(22) Date of filing: **01.07.2021**

(51) International Patent Classification (IPC):
B25J 17/02 *(2006.01)* ***B25J 9/00*** *(2006.01)*
B25J 9/10 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B25J 17/0275; B25J 9/104

(86) International application number:
PCT/KR2021/008360

(87) International publication number:
WO 2022/025453 (03.02.2022 Gazette 2022/05)

(54) **JOINT DEVICE FOR ROBOT**
GELENKVORRICHTUNG FÜR ROBOTER
DISPOSITIF D'ARTICULATION POUR ROBOT

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **28.07.2020 KR 20200093748**
22.09.2020 KR 20200122546

(43) Date of publication of application:
08.03.2023 Bulletin 2023/10

(73) Proprietor: **Samsung Electronics Co., Ltd.**
Gyeonggi-do 16677 (KR)

(72) Inventors:
- **HWANG, Cheoggyu**
  Suwon-si Gyeonggi-do 16677 (KR)
- **KIM, Jinwoong**
  Suwon-si Gyeonggi-do 16677 (KR)

(74) Representative: **Appleyard Lees IP LLP**
15 Clare Road
Halifax HX1 2HY (GB)

(56) References cited:
EP-A1- 3 620 269
WO-A1-2013/014720
CN-A- 109 866 250
JP-B1- 5 159 994
KR-A- 20160 002 664
US-A1- 2008 216 596
US-A1- 2011 296 944
US-A1- 2011 296 944
US-A1- 2015 298 909
US-A1- 2018 055 584

EP 4 144 492 B1

Processed by Luminess, 75001 PARIS (FR)

Description

TECHNICAL FIELD

[0001] The disclosure relates to a joint device for a robot, and more particularly, to a joint device for a robot having two-directional degrees of freedom of rotation using friction wheels.

BACKGROUND ART

[0002] A joint structure used in a robot may be manufactured in such a manner that a plurality of rotation shafts are sequentially combined. Specifically, a joint for a robot has a series structure in which a motor is directly connected to each rotation shaft, a link structure in which a heavy motor is concentrated to a lower end of a mechanism using a wire or a link, or an interference drive structure in which a plurality of degrees of freedom are connected in parallel.

[0003] The interference drive structure is widely used as a joint structure for a robot because a weight can be efficiently distributed by disposing a drive source near an upper shaft, a structure is simple, and modularization can be made in units of shafts.

[0004] In the related art, interference drive structures mainly use bevel gears or wires. However, in a case where a bevel gear is used, there are problems in that the gear needs to be machined with high precision, the production cost is very high, and it is difficult to support a load in an axial direction. In addition, when a wire is used, there are problems in that a degree of difficulty is high in terms of assembly and maintenance, and the volume of the entire structure increases because the wire needs to have a radius of curvature having a specific value or more.

[0005] US20110296944A1 proposes a robotic joint configured as a 3-axis joint. The joint includes an input roll assembly and a pitch-output roll assembly. The pitch-output roll assembly includes: a housing; a differential mechanism including left and right input gears, an output gear, a cross element interconnecting the gears, and a clevis supporting the gears and the cross element; a left four-bar linkage coupled to the left input gear; a right four-bar linkage coupled to the right input gear; and first and second linear actuators connected to the left and right four-bar linkages. The first and second linear actuators selectively drive the left and right input gears to rotate the output gear about an output roll axis and to rotate the cross element about a pitch axis passing through the cross element and input gears. A linear actuator in the input roll assembly rotates the pitch-output roll housing about an input roll axis.

[0006] US20180055584A1 relates to various robotic and/or in vivo medical devices having compact joint configurations and at least three degrees of freedom. Other embodiments relate to various medical device components, including forearms having grasper or cautery end effectors, that can be incorporated into certain robotic and/or in vivo medical devices.

[0007] CN109866250A relates to a robot wrist structure and a robot. The robot wrist structure comprises a shell, a first motor, a second motor, a first transmission mechanism, a second transmission mechanism, a first driving conical gear, a second driving conical gear, a driven conical gear, a holder, and an output connecting part; the first motor and the second motor are arranged on the shell, the first driving conical gear, the second driving conical gear, and the driven conical gear are rotatably mounted on the holder, the axis of the first driving conical gear is colinear with the axis of the second driving conical gear and is perpendicularly crossed with the driven conical gear, the first driving conical gear, and the second driving conical gear are engaged with the driven conical gear, the first motor is connected with the first driving conical gear through the first transmission mechanism, the second motor is connected with the second driving conical gear through the second transmission mechanism, and the output connecting part is fixedly connected with the driven conical gear. The robot wrist structure is diverse in motion mode, high in flexibility and wide in work range.

DISCLOSURE

TECHNICAL PROBLEM

[0008] The disclosure provides a joint device for a robot having two-directional degrees of freedom of rotation using friction wheels.

TECHNICAL SOLUTION

[0009] According to an aspect of the disclosure, there is provided a joint device according to claim 1.

[0010] More specific features are specified in the dependent claims.

[0011] .

BRIEF DESCRIPTION OF DRAWINGS

[0012]

FIG. 1 is a perspective view of a joint device for a robot according to an embodiment of the disclosure;

FIG. 2 is an exploded perspective view of the joint device for the robot of FIG. 1;

FIG. 3 is an exploded perspective view of components fitted on a first shaft;

FIG. 4 is a cross-sectional view taken along line A-A of the joint device for the robot of FIG. 1;

FIG. 5 is a view illustrating a state in which a third friction wheel rotates in a roll direction; and

FIG. 6 is a view illustrating a state in which the third friction wheel rotates in a pitch direction.

BEST MODE FOR CARRYING OUT THE INVENTION

[0013] It should be understood that embodiments to be described below are exemplarily provided to help the understanding of the disclosure, and the disclosure may be modified in various ways, unlike the embodiments described herein. However, in the following description of the disclosure, if it is determined that a detail description of a related known function or component may unnecessarily obscure the gist of the disclosure, the detailed description and concrete illustration thereof will be omitted. Further, the accompanying drawings are not necessarily illustrated to scale but dimensions of some components may be exaggerated to help the understanding of the disclosure.

[0014] The terms used in the specification and the claims are general terms selected in consideration of functions in the disclosure. However, these terms may vary depending on intentions of those skilled in the art, legal or technical interpretation, emergence of new technologies, and the like. Also, some terms may be arbitrarily selected by the applicant. These terms may be construed as meanings defined in the specification, and may be construed based on the entire text of the specification and the common technical knowledge in the art unless specifically defined.

[0015] In the specification, the expressions "have", "may have", "include", "may include", and the like indicate the presence of stated features (e.g., numbers, functions, operations, or components such as parts), but do not preclude the presence or additional features.

[0016] In addition, in the specification, components required for describing each embodiment of the disclosure are described, and the components are not necessarily limited thereto. Therefore, some components may be changed or omitted and other components may be added. In addition, components may be arranged in different independent devices in a distributed manner.

[0017] Furthermore, embodiments of the disclosure will hereinafter be described in detail with reference to the accompanying drawings and contents described in the accompanying drawings, but the disclosure is not limited or restricted by the embodiments.

[0018] Hereinafter, the disclosure will be described in more detail with reference to the accompanying drawings.

[0019] FIG. 1 is a perspective view of a joint device for a robot according to an embodiment of the disclosure. FIG. 2 is an exploded perspective view of the joint device for the robot of FIG. 1. FIG. 3 is an exploded perspective view of components fitted on a first shaft. FIG. 4 is a cross-sectional view taken along line A-A of the joint device for the robot of FIG. 1.

[0020] Referring to FIGS. 1 to 4, a joint device 1 for a robot according to an embodiment of the disclosure may include a first shaft 100, a second shaft 200, a first friction wheel 300, a second friction wheel 400, a third friction wheel 500, and a driving device 600.

[0021] The first shaft 100 may rotatably support the first friction wheel 300 and the second friction wheel 400 at opposite ends of the first shaft 100, respectively. Accordingly, the first and second friction wheels 300 and 400 may rotate around the first shaft 100 with the same rotation axis.

[0022] The first shaft 100 may be disposed parallel to a Y axis. That is, the rotation axis of the first and second friction wheels 300 and 400 may be parallel to the Y axis. The first shaft 100 may have a cylindrical shape.

[0023] The second shaft 200 may rotatably support the third friction wheel 500 at one end of the second shaft 200. Accordingly, the third friction wheel 500 may rotate around the second shaft 200.

[0024] The second shaft 200 may be disposed perpendicular to the first shaft 100. For example, the second shaft 200 may be disposed parallel to an X axis. That is, a rotation axis of the third friction wheel 500 may be parallel to the X axis. Like the first shaft 100, the second shaft 200 may have a cylindrical shape.

[0025] The second shaft 200 may be integrally formed with the first shaft 100. Specifically, the first and second shafts 100 and 200 may together form an integral shaft having a "T" or "X" shape to rotatably support the first, second, and third friction wheels 300, 400, and 500. However, the first and second shafts 100 and 200 may be formed separately, rather than integrally formed.

[0026] The first friction wheel 300 and the second friction wheel 400 may rotate in a state where they are fitted on the first shaft 100. The first and second friction wheels 300 and 400 may have a truncated cone shape.

[0027] The first and second friction wheels 300 and 400 may be arranged to be symmetric with respect to the second shaft 200. Specifically, the first and second friction wheels 300 and 400 may be disposed to have a cross section that becomes smaller as being closer to the second shaft 200.

[0028] The third friction wheel 500 may rotate in a state where they are fitted on the second shaft 200. The third friction wheel 500 may have a truncated cone shape. Specifically, the third friction wheel 500 may be disposed to have a cross section that becomes smaller as being closer to the first shaft 100.

[0029] The third friction wheel 500 may contact the first and second friction wheels 300 and 400 simultaneously at different positions. Accordingly, the third friction wheel 500 may be passively rotated by a rotational force transferred from the first and second friction wheels 300 and 400 due to a frictional force generated in portions contacting the first and second friction wheels 300 and 400.

[0030] The first, second, and third friction wheels 300, 400, and 500 may be formed of aluminum, but their material is not limited thereto. Accordingly, it is possible to reduce the weight of the joint device 1 for the robot and lower the overall specifications of the joint device 1 for the robot.

[0031] In addition, the first, second, and third friction wheels 300, 400, and 500 may smoothly rotate without noise because they continuously contact each other without teeth formed on their surfaces, which does not cause backlash. In addition, the first, second, and third friction wheels 300, 400, and 500 may be produced at a lower cost than gears, and may require fewer parts than wires, thereby reducing maintenance costs.

[0032] Specifically, a side surface of the third friction wheel 500 may simultaneously contact respective side surfaces of the first and second friction wheels 300 and 400. Specifically, the third friction wheel 500 may contact the first friction wheel 300 along a first line L1, and contact the second friction wheel 400 along a second line L2. Also, the first and second lines L1 and L2 may intersect at an intersection between central axes C1 and C2 of the first and second shafts 100 and 200.

[0033] When the first and second friction wheels 300 and 400 rotate in the same direction, the third friction wheel 500 may rotate in a pitch direction because the third friction wheel 500 receives a frictional force from the first and second friction wheels 300 and 400 in the same direction. The pitch direction may be a direction of rotation with respect to a rotation axis parallel to the Y axis.

[0034] When the first and second friction wheels 300 and 400 rotate in opposite directions, the third friction wheel 500 may rotate in a roll direction because the third friction wheel 500 receives a frictional force from the first and second friction wheels 300 and 400 in different directions. The roll direction may be a direction of rotation with respect to a rotation axis parallel to the X axis.

[0035] That is, the third friction wheel 500 may be passively rotated by a rotational force transferred from the first and second friction wheels 300 and 400, and may have two degrees of freedom of rotation depending on the rotation directions of the first and second friction wheels 300 and 400. A process in which the third friction wheel 500 rotates based on the two degrees of freedom of rotation will be described in detail with reference to FIGS. 5 and 6.

[0036] A connection plate 510 may be disposed on a front surface of the third friction wheel 500. The connection plate 510 may have a disk shape and may be coupled to the third friction wheel 500 to rotate integrally with the third friction wheel 500.

[0037] Any one of various robot structures may be coupled to the connection plate 510. For example, any one of various parts of the robot, such as an arm, a hand, a foot, a leg, and a head, may be coupled to the connection plate 510 to rotate together with the third friction wheel 500.

[0038] Bearings 501 and 502 may be disposed between the third friction wheel 500 and the second shaft 200. Although the two bearings 501 and 502 are illustrated, the number of bearings is not limited thereto.

[0039] The bearings 501 and 502 may be angular ball bearings, but the bearing type is not limited thereto. The bearings 501 and 502 enables the third friction wheel 500 to easily rotate relative to the second shaft 200, which is stationary.

[0040] The driving device 600 may rotate each of the first and second friction wheels 300 and 400. For example, the driving device 600 may include a first motor 610 and a second motor 620. The first motor 610 may rotate the first friction wheel 300, and the second motor 620 may rotate the second friction wheel 400.

[0041] The first and second motors 610 and 620 may be supported by a frame 700, and may be positioned behind the first, second, and third friction wheels 300, 400, and 500.

[0042] For example, the driving device 600 may further include a first pulley 630, a second pulley 640, a first timing belt 650, and a second timing belt 660.

[0043] The first and second pulleys 630 and 640 may be fitted on the first shaft 100 to rotate around the first shaft 100. The first pulley 630 may be disposed on a rear surface of the first friction wheel 300, and the second pulley 640 may be disposed at a rear surface of the second friction wheel 400.

[0044] The first timing belt 650 may partially surround a circumference of the first pulley 630 to provide a driving force of the first motor 610 to the first pulley 630. In addition, the first pulley 630 may be coupled to the first friction wheel 300 to rotate integrally with the first friction wheel 300.

[0045] Similarly, the second timing belt 660 may partially surround a circumference of the second pulley 640 to provide a driving force of the second motor 620 to the second pulley 640, and the second pulley 640 may be coupled to the second friction wheel 400 to rotate integrally with the second friction wheel 400.

[0046] However, the above-described structure of the driving device 600 is an example, and the structure of the driving device 600 is not limited thereto. The driving device 600 may be implemented in any structure as long as it is capable of rotating the first and second friction wheels 300 and 400.

[0047] The joint device 1 for the robot may further include a first pressing member 310 and a second pressing member 410. The first pressing member 310 may press the first friction wheel 300 toward the third friction wheel 500. The second pressing member 410 may press the second friction wheel 400 toward the third friction wheel 500.

[0048] As a result, the first and second pressing members 310 and 410 provide a pre-load to the first and second friction wheels 300 and 400, thereby providing a sufficient frictional force to the third friction wheel 500. Accordingly, a rotational force of the first and second friction wheels 300 and 400 may be easily transferred to the third friction wheel 500.

[0049] For example, the first and second pressing members 310 and 410 may be disk springs fitted on the first shaft 100. The disc springs are capable of pressurize the first and second friction wheels 300 and 400, respectively, with a large elastic force even with a small displacement. Accordingly, the rotational force of the first and second friction wheels 300 and 400 can be more effectively transferred to the third friction wheel 500, so that the joint device 1 for the robot can be manufactured in a small size.

[0050] The joint device 1 for the robot may further include a first nut 320 and a second nut 420. The first nut 320 may be fitted at one end of the first shaft 100 to support one end of the first pressing member 310. The second nut 420 may be fitted at the other end of the first shaft 100 to support one end of the second pressing member 410.

[0051] For example, the first and second nuts 320 and 420 may be fixed by screw threads formed on side surfaces of the first shaft 100. The pre-load of the first and second pressing members 310 and 410 may be adjusted depending on how much the first and second nuts 320 and 420 are tightened on the first shaft 100.

[0052] The joint device 1 for the robot may further include a first bearing 330 and a second bearing 430. The first bearing 330 may be disposed between the first shaft 100 and the first friction wheel 300. The second bearing 430 may be disposed between the first shaft 100 and the second friction wheel 400.

[0053] The first and second bearings 330 and 430 enable the first and second friction wheels 300 and 400 to easily rotate relative to the first shaft 100, which is stationary.

[0054] The first and second bearings 330 and 430 may be angular ball bearings, each being capable of transferring an axial-directional load in an easier way. The angular ball bearing is capable of transferring a load in an axial direction as well as in a radial direction in an easy way because a straight line connecting contact points between a ball and inner and outer rings forms a predetermined angle with respect to the radial direction.

[0055] Accordingly, the first bearing 330 makes it possible to more easily transfer an elastic force transferred from the first pressing member 310 to the first friction wheel 300. Similarly, the second bearing 430 makes it possible to more easily transfer an elastic force from the second pressing member 410 to the second friction wheel 400.

[0056] Specifically, the inner ring 331 and the outer ring 333 of the first bearing 330 may contact the first pressing member 310 and the first friction wheel 300, respectively. Accordingly, an elastic force of the first pressing member 310 may be transferred sequentially through the inner ring 331, the ball 332, and the outer ring 333 of the first bearing 330, and finally transferred to the first friction wheel 300.

[0057] Similarly, the inner ring 431 and the outer ring 433 of the second bearing 430 may contact the second pressing member 410 and the second friction wheel 400, respectively. Accordingly, an elastic force of the second pressing member 410 may be transferred sequentially through the inner ring 431, the ball 432, and the outer ring 433 of the second bearing 430, and finally transferred to the second friction wheel 400.

[0058] That is, the first and second pressing members 310 and 410 may press the inner rings 331 and 431 of the first and second bearings 330 and 430, which are stationary together with the first shaft 100. Accordingly, since the objects pressed by the first and second pressing members 310 and 410 are stationary, it is possible to minimize wear resulting from friction.

[0059] In addition, the first and second pressing members 310 and 410 may have a convex shape toward the inner rings 331 and 431 of the first and second bearings 330 and 430. For example, the first and second pressing members 310 and 410 may be cone-shaped disk springs each having an opening in a central portion.

[0060] Accordingly, the above-described shape of the first and second pressing members 310 and 410 makes it possible to press only the inner rings 331 and 431, which are stationary, not the outer rings 333 and 433, which are rotating, respectively.

[0061] The frame 700 may be disposed on a rear side of the joint device 1 for the robot to support the first shaft 100 and the driving device 600. However, this is an example, and the shape and the arrangement of the frame 700 are not limited thereto.

[0062] In addition, the joint device 1 for the robot may further include a fourth friction wheel 800. The fourth friction wheel 800 may be rotatably supported at the other end of the second shaft 200 intersecting the first shaft 100.

[0063] The fourth friction wheel 800 may contact each of the first and second friction wheels 300 and 400. For example, the fourth friction wheel 800 may have a truncated cone shape, and a side surface of the fourth friction wheel 800 may contact the side surfaces of the first and second friction wheels 300 and 400 simultaneously at different positions.

[0064] The fourth friction wheel 800 may have a shape to be symmetric to the third friction wheel 500 with respect to the first shaft 100. Specifically, the fourth friction wheel 800 may have a truncated cone shape with a cross section gradually decreasing toward the first shaft 100.

[0065] The fourth friction wheel 800 may face the third friction wheel 500, and may rotate in the opposite direction to the third friction wheel 500.

[0066] In addition, the fourth friction wheel 800 may support an area of each of the first and second pressing members 310 and 410 on the rear side thereof. Accordingly, the fourth friction wheel 800 may prevent the first and second friction wheels 300 and 400 from being deformed or the rotational axis of the first and second friction wheels 300 and 400 from being misaligned due to the elastic force of the first and second pressing members 310 and 410.

[0067] FIG. 5 is a view illustrating a state in which the third friction wheel rotates in the roll direction. Referring to

FIG. 5, the first and second friction wheels 300 and 400 may rotate in different directions.

[0068] For example, when the first friction wheel 300 rotates in an R1 direction and the second friction wheel 400 rotates in an R2 direction, the third friction wheel 500 rotates around the second shaft 200 in an R4 direction. At this time, the fourth friction wheel 800 may rotate around the second shaft 200 in an R3 direction as opposed to the third friction wheel 500.

[0069] Conversely, when the first friction wheel 300 rotates in the R2 direction and the second friction wheel 400 rotates in the R1 direction, the third friction wheel 500 may rotate around the second shaft 200 in the R3 direction. At this time, the fourth friction wheel 800 may rotate around the second shaft 200 in the R4 direction as opposed to the third friction wheel 500.

[0070] That is, when the first and second friction wheels 300 and 400 rotate in different directions, the third friction wheel 500 may rotate around the second shaft 200 in the roll direction.

[0071] FIG. 6 is a view illustrating a state in which the third friction wheel rotates in a pitch direction. Referring to FIG. 6, the first and second friction wheels 300 and 400 may rotate in the same direction.

[0072] For example, when both the first and second friction wheels 300 and 400 rotate in the R1 direction, the third friction wheel 500 may rotate around the first shaft 100 in the R1 direction. At this time, the fourth friction wheel 800 may rotate around the first shaft 100 in the R2 direction as opposed to the third friction wheel 500.

[0073] Conversely, when both the first and second friction wheels 300 and 400 rotate in the R2 direction, the third friction wheel 500 may also rotate around the first shaft 100 in the R2 direction. At this time, the fourth friction wheel 800 may rotate around the first shaft 100 in the R1 direction as opposed to the third friction wheel 500.

[0074] Specifically, the frame 700 may rotatably support both ends of the first shaft 100, and the first and second shafts 100 and 200 may be integrally formed. In this case, when the first and second friction wheels 300 and 400 rotate in the same direction, the first shaft 100, the second shaft 200, and the third friction wheel 500 may rotate around the first shaft 100 in the R1 or R2 direction.

[0075] That is, when the first and second friction wheels 300 and 400 rotate in the same direction, the third friction wheel 500 may rotate around the first shaft 100 in the pitch direction.

[0076] Accordingly, the third friction wheel 500 may be passively rotated with two degrees of freedom of rotation depending on the rotation directions of the first and second friction wheels 300 and 400.

[0077] Although embodiments of the disclosure have been illustrated and described, the disclosure is not limited to the specific embodiments as described above, and may be variously modified by those skilled in the art to which the disclosure pertains without departing from the gist of the disclosure as claimed in the appended claims. Such modifications fall within the scope of the claims..

Claims

1. A joint device (1) for a robot, the joint device (1) comprising:

    a first shaft (100);
    a second shaft (200) disposed perpendicular to the first shaft (100);
    a first friction wheel (300) rotatably supported by a first end of the first shaft (100);
    a second friction wheel (400) rotatably supported by a second end of the first shaft (100);
    a driving device (600) configured to rotate each of the first friction wheel (300) and the second friction wheel (400);
    a third friction wheel (500) rotatably supported by a first end of the second shaft (200), and contacting the first friction wheel (300) and the second friction wheels (400),
    wherein when the first friction wheel (300) and the second friction wheel (400) rotate in the same direction, the third friction wheel rotates in a pitch direction, and
    wherein when the first friction wheel (300) and the second friction wheel (400) rotate in different directions, the third friction wheel (500) rotates in a roll direction,
    characterized in that:
    the joint device (1) comprises:

        a first pressing member (310) configured to press the first friction wheel (300) toward the third friction wheel (500);
        a second pressing member (410) configured to press the second friction wheel (400) toward the third friction wheel (500);
        a first angular ball bearing (330) interposed between the first shaft (100) and the first friction wheel (300); and
        a second angular ball bearing (430) interposed between the first shaft (100) and the second friction wheel (400),
        wherein:

            the first angular ball bearing (330) comprises an inner ring (331) that contacts the first pressing member (310), and an outer ring (333) that contacts the first friction wheel (300), and
            the second angular ball bearing (430) comprises an inner ring (431) that contacts the second pressing member (410), and an outer ring (433) that contacts the second friction wheel (400).

2. The joint device (1) of claim 1, wherein each of the first friction wheel (300), the second friction wheel (400), and the third friction wheel (500) has a truncated cone shape, and
wherein a side surface of the third friction wheel (500) contacts a side surface of each of the first friction wheel (300) and the second friction wheel (400).

3. The joint device (1) of claim 2, wherein the third friction wheel (500) contacts the first friction wheel (300) along a first line (L1),

wherein the third friction wheel (500) contacts the second friction wheel (400) along a second line (L2), and
wherein the first line (L1) and the second line (L2) intersect at an intersection between a central axis of the first shaft (100) and a central axis of the second shaft (200).

4. The joint device (1) of claim 1, wherein each of the first pressing member (310) and the second pressing member (410) comprises a disk spring fitted on the first shaft (100).

5. The joint device (1) of claim 1, further comprising:

a first nut (320) fitted at the first end of the first shaft (100) to support an end of the first pressing member (310); and
a second nut (420) fitted at the second end of the first shaft (100) to support an end of the second pressing member (410).

6. The joint device (1) of claim 1, wherein the first pressing member (310) has a convex shape toward the inner ring (331) of the first angular ball bearing (330), and the second pressing member (410) has a convex shape toward the inner ring (431) of the second angular ball bearing (430).

7. The joint device (1) of claim 1, wherein the driving device (600) comprises:

a first motor (610) configured to rotate the first friction wheel; and
a second motor (620) configured to rotate the second friction wheel.

8. The joint device of claim 7, wherein the driving device (600) further comprises:

a first pulley (630) coupled to the first friction wheel (300);
a second pulley (640) coupled to the second friction wheel (400);
a first timing belt (650) configured to provide a driving force of the first motor (610) to the first pulley (630); and
a second timing belt (660) configured to provide a driving force of the second motor (620) to the second pulley (640).

9. The joint device (1) of claim 1, further comprising:

a fourth friction wheel (800) rotatably supported by a second end of the second shaft (200), the second shaft (200) intersecting the first shaft (100),
wherein the fourth friction wheel (800) contacts each of the first friction wheel (300) and the second friction wheel (400).

10. The joint device (1) of claim 1, further comprising: a frame (700) rotatably supporting the first end and the second end of the first shaft (300).

11. The joint device (1) of claim 10, wherein the first shaft (100) and the second shaft (200) are integrally formed,

wherein when the first friction wheel (300) and the second friction wheel (400) rotate in the same direction, the first shaft (100), the second shaft (200), and the third friction wheel (500) rotate around the first shaft (100), and
wherein when the first friction wheel (300) and the second friction wheel (400) rotate in different directions, the third friction wheel (500) rotates around the second shaft (200).

Patentansprüche

1. Gelenkvorrichtung (1) für einen Roboter, wobei die Gelenkvorrichtung (1) Folgendes umfasst:

eine erste Welle (100);
eine zweite Welle (200), die senkrecht zur ersten Welle (100) angeordnet ist;
ein erstes Reibrad (300), das drehbar von einem ersten Ende der ersten Welle (100) getragen wird;
ein zweites Reibrad (400), das drehbar von einem zweiten Ende der ersten Welle (100) getragen wird;
eine Antriebsvorrichtung (600), die so konfiguriert ist, dass sie sowohl das erste Reibrad (300) als auch das zweite Reibrad (400) dreht;
ein drittes Reibrad (500), das drehbar von einem ersten Ende der zweiten Welle (200) getragen wird und das erste Reibrad (300) und die zweiten Reibräder (400) berührt, wobei, wenn das erste Reibrad (300) und das zweite Reibrad (400) in die gleiche Richtung rotieren, das dritte Reibrad in eine Nickrichtung rotiert, und

wobei, wenn das erste Reibrad (300) und das zweite Reibrad (400) in unterschiedliche Richtungen rotieren, das dritte Reibrad (500) in eine Rollrichtung rotiert,
dadurch gekennzeichnet, dass:
die Gelenkvorrichtung (1) Folgendes umfasst:

ein erstes Druckelement (310), das dazu konfiguriert ist, das erste Reibrad (300) in Richtung des dritten Reibrads (500) zu drücken;
ein zweites Druckelement (410), das dazu konfiguriert ist, das zweite Reibrad (400) in Richtung des dritten Reibrads (500) zu drücken;
ein erstes Schrägkugellager (330), das zwischen der ersten Welle (100) und dem ersten Reibrad (300) angeordnet ist; und
ein zweites Schrägkugellager (430), das zwischen der ersten Welle (100) und dem zweiten Reibrad (400) angeordnet ist,
wobei:

das erste Schrägkugellager (830) einen Innenring (331) umfasst, der das erste Druckelement (310) berührt, und einen Außenring (833), der das erste Reibrad (300) berührt, und
das zweite Schrägkugellager (430) einen Innenring (431) umfasst, der das zweite Druckelement (410) berührt, und einen Außenring (433), der das zweite Reibrad (400) berührt.

2. Gelenkvorrichtung (1) nach Anspruch 1, wobei das erste Reibrad (300), das zweite Reibrad (400) und das dritte Reibrad (500) jeweils eine Kegelstumpfform aufweisen, und wobei eine Seitenfläche des dritten Reibrads (500) jeweils eine Seitenfläche des ersten Reibrads (300) und des zweiten Reibrads (400) berührt.

3. Gelenkvorrichtung (1) nach Anspruch 2, wobei das dritte Reibrad (500) das erste Reibrad (300) entlang einer ersten Linie (L1) berührt,

wobei das dritte Reibrad (500) das zweite Reibrad (400) entlang einer zweiten Linie (L2) berührt, und
wobei sich die erste Linie (L1) und die zweite Linie (L2) an einem Schnittpunkt zwischen einer Mittelachse der ersten Welle (100) und einer Mittelachse der zweiten Welle (200) schneiden.

4. Gelenkvorrichtung (1) nach Anspruch 1, wobei das erste Druckelement (310) und das zweite Druckelement (410) jeweils eine Tellerfeder umfassen, die auf der ersten Welle (100) angebracht ist.

5. Gelenkvorrichtung (1) nach Anspruch 1, ferner umfassend:

eine erste Mutter (320), die am ersten Ende der ersten Welle (100) angebracht ist, um ein Ende des ersten Druckelements (310) zu stützen; und
eine zweite Mutter (420), die am zweiten Ende der ersten Welle (100) angebracht ist, um ein Ende des zweiten Druckelements (410) zu stützen.

6. Gelenkvorrichtung (1) nach Anspruch 1, wobei das erste Druckelement (310) eine konvexe Form in Richtung des Innenrings (331) des ersten Schrägkugellagers (330) aufweist und das zweite Druckelement (410) eine konvexe Form in Richtung des Innenrings (431) des zweiten Schrägkugellagers (430) aufweist.

7. Gelenkvorrichtung (1) nach Anspruch 1, wobei die Antriebsvorrichtung (600) Folgendes umfasst:

einen ersten Motor (610), der zum Drehen des ersten Reibrads konfiguriert ist; und
einen zweiten Motor (620), der zum Drehen des zweiten Reibrads konfiguriert ist.

8. Gelenkvorrichtung nach Anspruch 7, wobei die Antriebsvorrichtung (600) ferner Folgendes umfasst:

eine erste Riemenscheibe (630), die mit dem ersten Reibrad (300) gekoppelt ist;
eine zweite Riemenscheibe (640), die mit dem zweiten Reibrad (400) gekoppelt ist;
einen ersten Zahnriemen (650), der dazu konfiguriert ist, eine Antriebskraft des ersten Motors (610) auf die erste Riemenscheibe (630) zu übertragen; und
einen zweiten Zahnriemen (660), der dazu konfiguriert ist, eine Antriebskraft des zweiten Motors (620) auf die zweite Riemenscheibe (640) zu übertragen.

9. Gelenkvorrichtung (1) nach Anspruch 1, ferner umfassend:

ein viertes Reibrad (800), das drehbar von einem zweiten Ende der zweiten Welle (200) getragen wird, wobei die zweite Welle (200) die erste Welle (100) kreuzt,
wobei das vierte Reibrad (800) sowohl das erste Reibrad (300) als auch das zweite Reibrad (400) berührt.

10. Gelenkvorrichtung (1) nach Anspruch 1, ferner umfassend:
einen Rahmen (700), der das erste Ende und das zweite Ende der ersten Welle (300) drehbar trägt.

11. Gelenkvorrichtung (1) nach Anspruch 10, wobei die erste Welle (100) und die zweite Welle (200) einstückig ausgebildet sind,

wobei, wenn das erste Reibrad (300) und das zweite Reibrad (400) in die gleiche Richtung rotieren, die erste Welle (100), die zweite Welle (200) und das dritte Reibrad (500) um die erste Welle (100) rotieren, und
wobei, wenn das erste Reibrad (300) und das zweite Reibrad (400) in unterschiedliche Richtungen rotieren, das dritte Reibrad (500) um die zweite Welle (200) rotiert.

Revendications

1. Dispositif d'articulation (1) pour un robot, le dispositif d'articulation (1) comprenant :

un premier arbre (100) ;
un second arbre (200) disposé perpendiculairement au premier arbre (100) ;
une première roue de friction (300) supportée de manière rotative par une première extrémité du premier arbre (100) ;
une deuxième roue de friction (400) supportée de manière rotative par une seconde extrémité du premier arbre (100) ;
un dispositif d'entraînement (600) configuré pour faire tourner chacune de la première roue de friction (300) et de la deuxième roue de friction (400) ;
une troisième roue de friction (500) supportée de manière rotative par une première extrémité du second arbre (200), et en contact avec la première roue de friction (300) et les deuxièmes roues de friction (400),
dans lequel lorsque la première roue de friction (300) et la deuxième roue de friction (400) tournent dans la même direction, la troisième roue de friction tourne dans une direction de pas, et
dans lequel lorsque la première roue de friction (300) et la deuxième roue de friction (400) tournent dans des directions différentes, la troisième roue de friction (500) tourne dans une direction de roulis,
caractérisé en ce que :
le dispositif d'articulation (1) comprend :

un premier élément de pression (310) configuré pour presser la première roue de friction (300) vers la troisième roue de friction (500) ;
un second élément de pression (410) configuré pour presser la deuxième roue de friction (400) vers la troisième roue de friction (500) ;
un premier roulement à billes angulaire (330) interposé entre le premier arbre (100) et la première roue de friction (300) ; et
un second roulement à billes angulaire (430) interposé entre le premier arbre (100) et la deuxième roue de friction (400), dans lequel :

le premier roulement à billes angulaire (330) comprend une bague intérieure (331) qui entre en contact avec le premier élément de pression (310), et une bague extérieure (333) qui entre en contact avec la première roue de friction (300), et
le second roulement à billes angulaire (430) comprend une bague intérieure (431) qui entre en contact avec le second élément de pression (410), et une bague extérieure (433) qui entre en contact avec la deuxième roue de friction (400).

2. Dispositif d'articulation (1) selon la revendication 1, dans lequel chacune des première (300) roues de friction, deuxième roues de friction (400) et troisième roues de friction (500) a une forme de cône tronqué, et
dans lequel une surface latérale de la troisième roue de friction (500) entre en contact avec une surface latérale de chacune des première (300) et deuxième roues de friction (400).

3. Dispositif d'articulation (1) selon la revendication 2, dans lequel la troisième roue de friction (500) entre en contact avec la première roue de friction (300) le long d'une première ligne (L1),

dans lequel la troisième roue de friction (500) entre en contact avec la deuxième roue de friction (400) le long d'une seconde ligne (L2), et
dans lequel la première ligne (L1) et la seconde ligne (L2) se croisent à une intersection entre un axe central du premier arbre (100) et un axe central du second arbre (200).

4. Dispositif d'articulation (1) selon la revendication 1, dans lequel chacun du premier élément de pression (310) et du second élément de pression (410) comprend un ressort à disque monté sur le premier arbre (100).

5. Dispositif d'articulation (1) selon la revendication 1, comprenant en outre :

un premier écrou (320) monté à la première extrémité du premier arbre (100) pour supporter

une extrémité du premier élément de pression (310) ; et
un second écrou (420) monté à la seconde extrémité du premier arbre (100) pour supporter une extrémité du second élément de pression (410).

6. Dispositif d'articulation (1) selon la revendication 1, dans lequel le premier élément de pression (310) a une forme convexe vers la bague intérieure (331) du premier roulement à billes angulaire (330), et le second élément de pression (410) a une forme convexe vers la bague intérieure (431) du second roulement à billes angulaire (430).

7. Dispositif d'articulation (1) selon la revendication 1, dans lequel le dispositif d'entraînement (600) comprend :

un premier moteur (610) configuré pour faire tourner la première roue de friction ; et
un second moteur (620) configuré pour faire tourner la deuxième roue de friction.

8. Dispositif d'articulation selon la revendication 7, dans lequel le dispositif d'entraînement (600) comprend en outre :

une première poulie (630) couplée à la première roue de friction (300) ;
une seconde poulie (640) couplée à la deuxième roue de friction (400) ;
une première courroie de distribution (650) configurée pour fournir une force motrice du premier moteur (610) à la première poulie (630) ; et
une seconde courroie de distribution (660) configurée pour fournir une force motrice du second moteur (620) à la seconde poulie (640).

9. Dispositif d'articulation (1) selon la revendication 1, comprenant en outre :

une quatrième roue de friction (800) supportée de manière rotative par une seconde extrémité du second arbre (200), le second arbre (200) croisant le premier arbre (100),
dans lequel la quatrième roue de friction (800) entre en contact avec chacune des première roues de friction (300) et deuxième roues de friction (400).

10. Dispositif d'articulation (1) selon la revendication 1, comprenant en outre :
un cadre (700) supportant de manière rotative la première extrémité et la seconde extrémité du premier arbre (300).

11. Dispositif d'articulation (1) selon la revendication 10, dans lequel le premier arbre (100) et le second arbre (200) sont formés d'un seul tenant,

dans lequel lorsque la première roue de friction (300) et la deuxième roue de friction (400) tournent dans la même direction, le premier arbre (100), le second arbre (200) et la troisième roue de friction (500) tournent autour du premier arbre (100), et
dans lequel lorsque la première roue de friction (300) et la deuxième roue de friction (400) tournent dans des directions différentes, la troisième roue de friction (500) tourne autour du second arbre (200).

FIG. 1

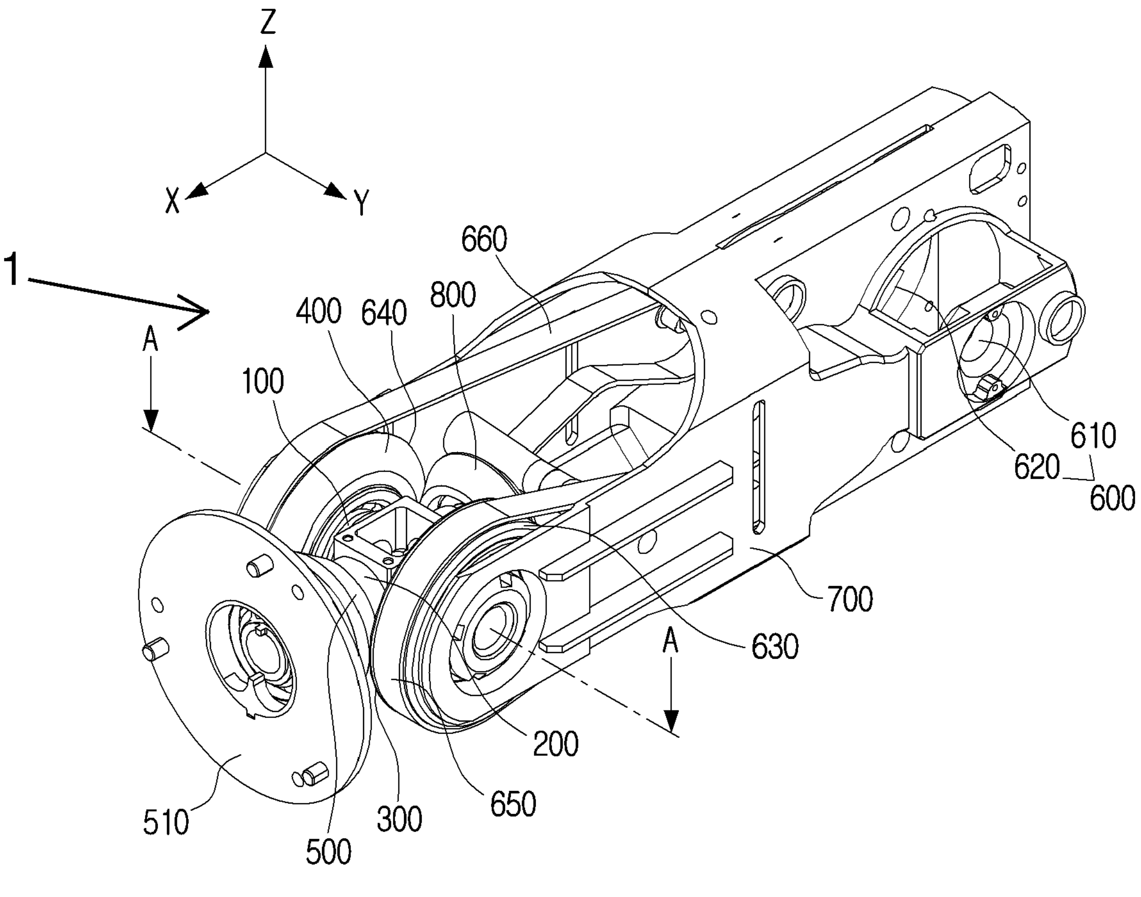

Z
X
Y
1
A
660
400
640
800
100
610
620
600
700
630
A
200
650
300
500
510

FIG. 2

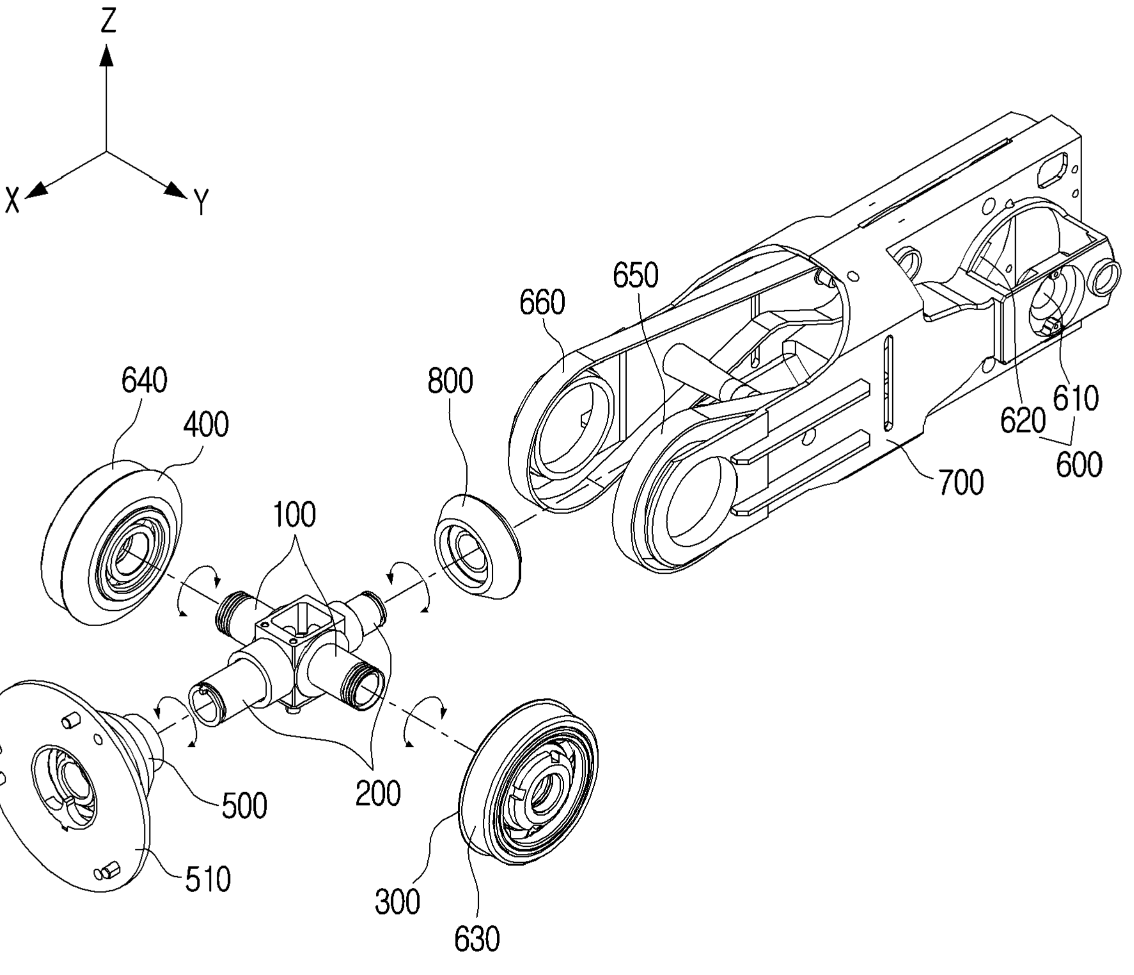


FIG. 3

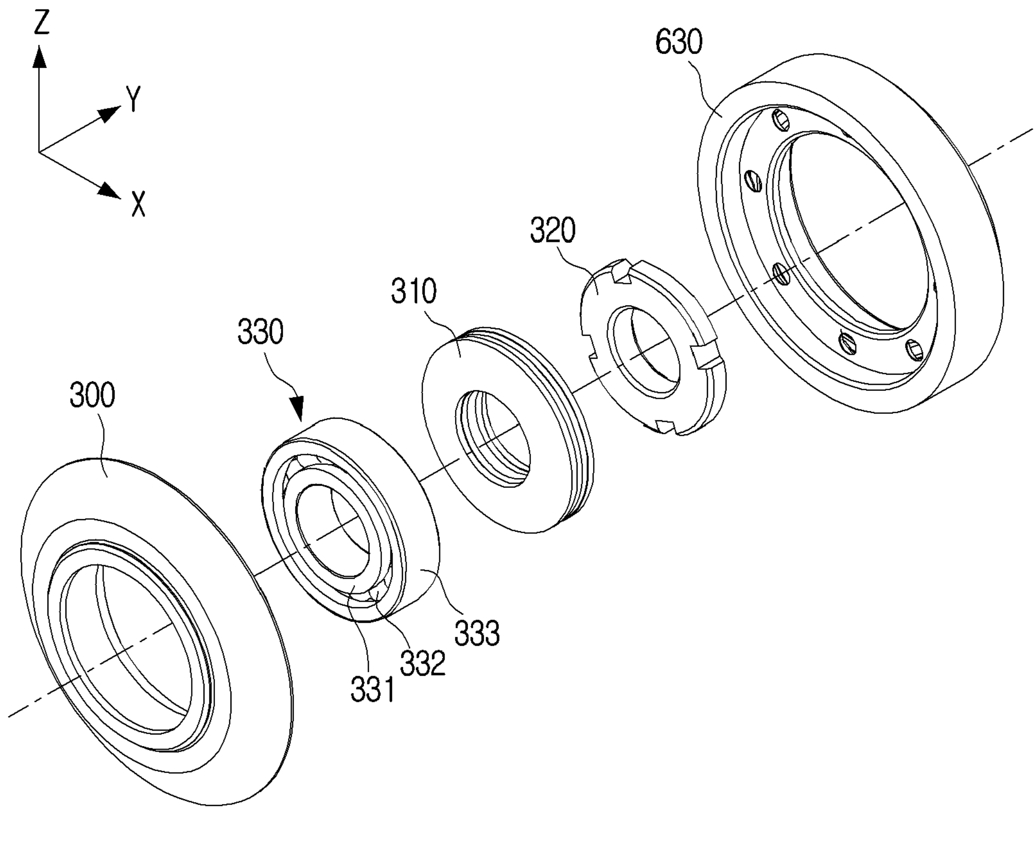


FIG. 4

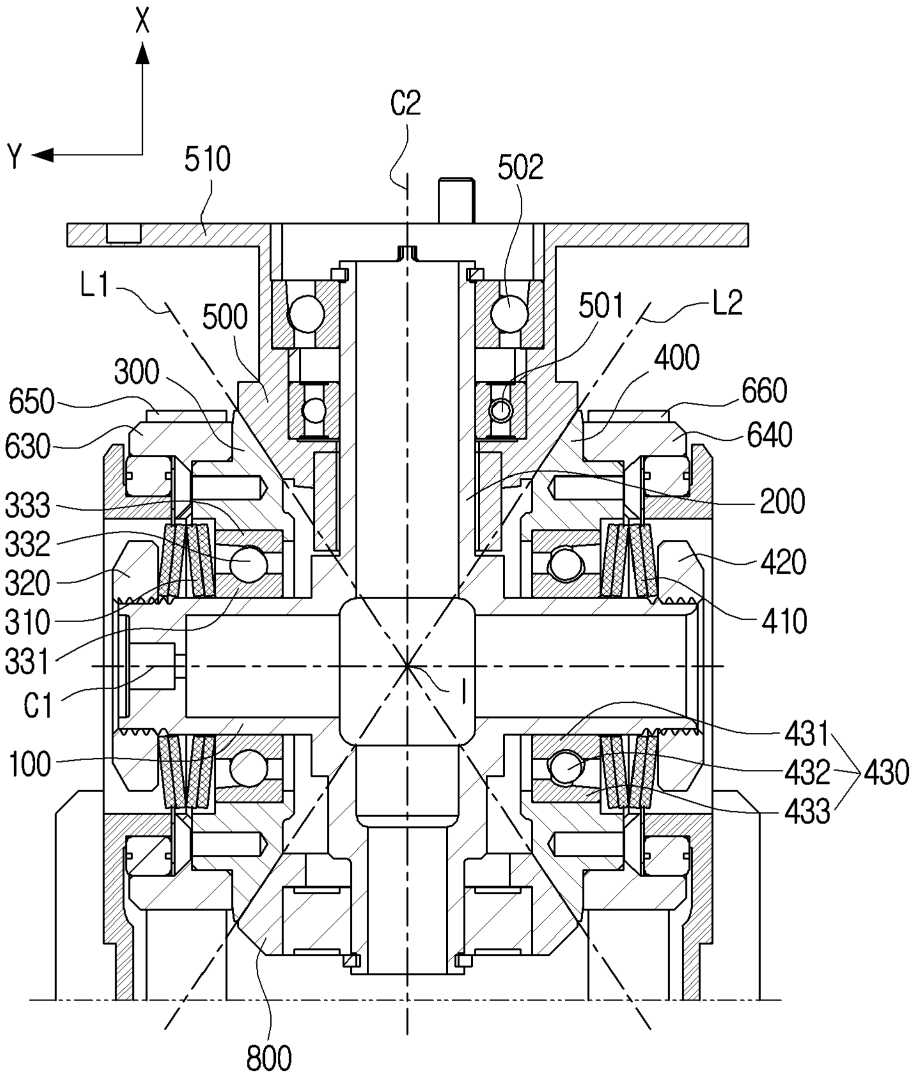

X
Y
C2
510
502
L1
500
501
L2
300
400
650
660
630
640
333
200
332
420
320
310
410
331
C1
I
431
100
432
430
433
800

FIG. 5

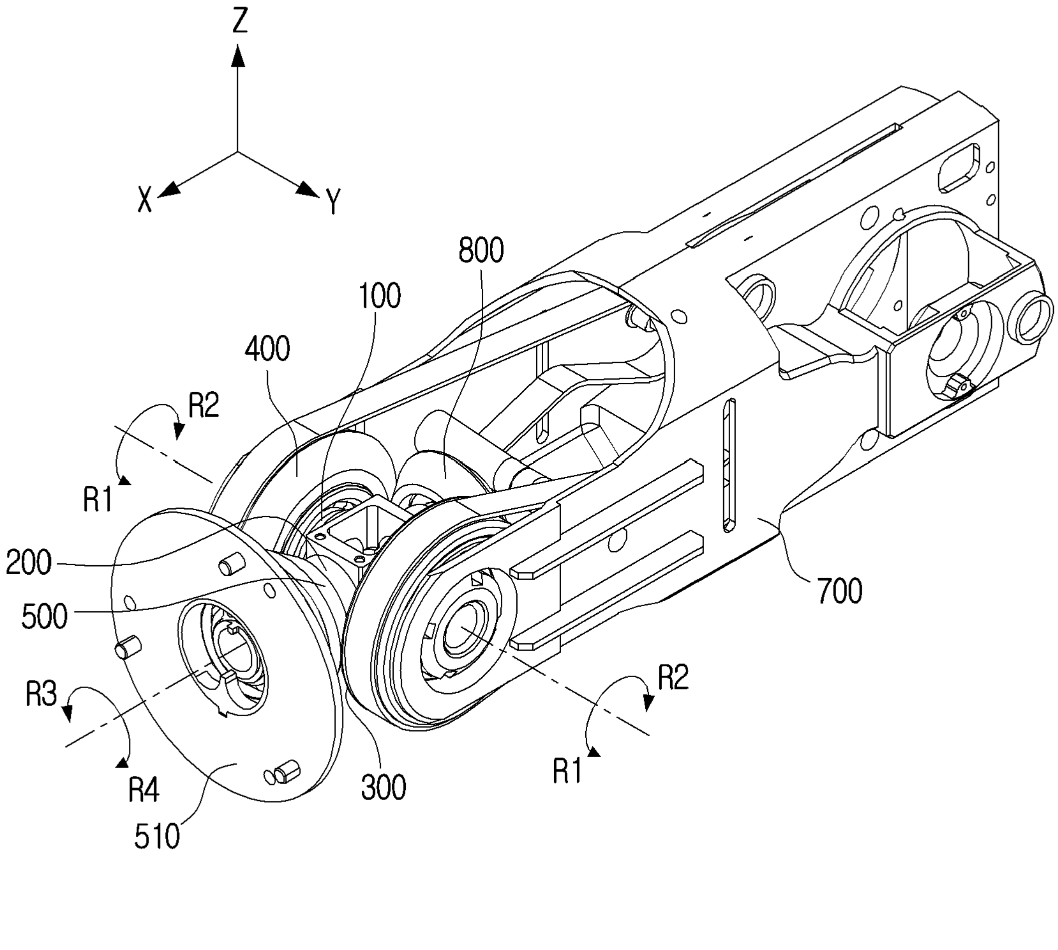
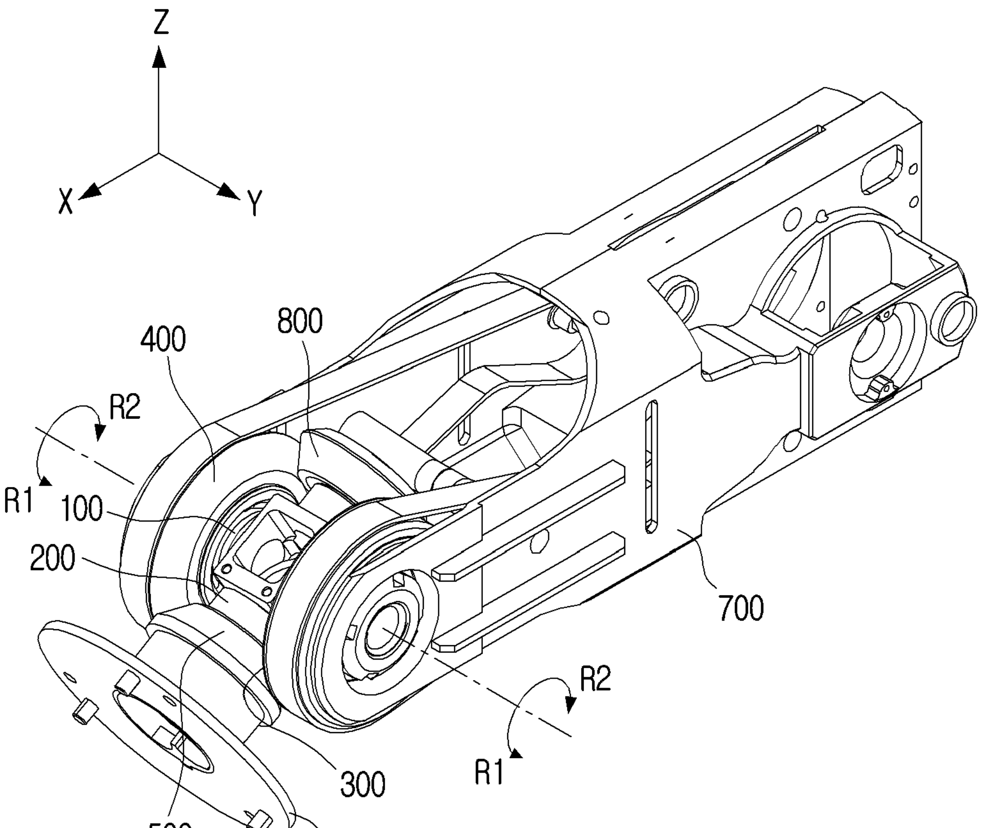


FIG. 6



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20110296944 A1 **[0005]**
- US 20180055584 A1 **[0006]**
- CN 109866250 A **[0007]**